Evolutionary Systematics. 9 2025, 99–106 | DOI 10.3897/evolsyst.9.146658

PENSOFT

EVOLUTIONARY SYSTEMATICS

New sightings reveal establishment and spread of the allochthonous mantid *Ameles spallanzania* Rossi, 1792 in Hungary (Insecta, Mantodea)

Áron Székely[1,2], Márk László[3,4], Ádám Mészáros[2,5,6], Bence Péter Schlitt[1,2,7]

1 *Institute of Biology, ELTE Eötvös Loránd University, Pázmány Péter sétány 1/C, H-1117 Budapest, Hungary*
2 *Young Entomologists' Club Research Group, ArtEnto Foundation, Bródy Sándor utca 32, H-1088 Budapest, Hungary*
3 *Department of Systematic Zoology and Ecology, ELTE Eötvös Loránd University, Pázmány Péter sétány 1/C, H-1117 Budapest, Hungary*
4 *Doctoral School of Biology, ELTE Eötvös Loránd University, Pázmány Péter sétány 1/C, H-1117 Budapest, Hungary*
5 *Institute of Aquatic Ecology, Centre for Ecological Research, Karolina út 29, H-1113 Budapest, Hungary*
6 *Doctoral School of Environmental Sciences, ELTE Eötvös Loránd University, Pázmány Péter sétány 1/C, H-1117 Budapest, Hungary*
7 *Hemiptera Collection, Department of Zoology, Hungarian National Museum Public Collections Centre – Hungarian Natural History Museum, Baross utca 13, H-1088 Budapest, Hungary*

https://zoobank.org/194E0FFA-7AA9-4060-A091-6156F7FEE264

Corresponding author: Áron Székely (aronszekely2@gmail.com)

Academic editor: Karina L. Silva-Brandão ♦ **Received** 13 January 2025 ♦ **Accepted** 31 March 2025 ♦ **Published** 23 April 2025

Abstract

Biological invasions driven by climate change are one of the major challenges of today's native ecosystems. One species that undergoes such a phenomenon is *Ameles spallanzania* Rossi, 1792 (Insecta, Mantodea, Amelidae), a Mediterranean mantid with an extensive range expansion over the last few years. Although several studies mention this northward shift, only one occurrence has been published from Hungary until now. We present all the 27 new localities and data on this allochthonous species, concluding that it has established breeding populations in Hungary, with a growing number of observations suggesting continued expansion towards Central Europe.

Key Words

Allochthonous species, citizen science, climate change, distribution, faunistics, invasive species

Introduction

Climate change and biological invasions are significantly impacting European ecosystems (Hulme 2017; IPCC 2019). With global temperatures already rising by about 1.0 °C since pre-industrial times and expected to reach 1.5 °C within a few decades (Allen et al. 2018), extreme weather events and habitat changes are becoming more common (Clarke et al. 2022). Many species are shifting or expanding their ranges to adapt (e.g. Chen et al. 2011; Ryan et al. 2019; O'Neill et al. 2024), leading to an increase in non-native species in Europe (Seebens et al. 2017; Seebens et al. 2020) and causing major ecological transitions (e.g. Walther et al. 2002; Vitali et al. 2023). Another aspect of the appearance and later establishment of non-native species lies not only in the natural climate-driven expansion itself, but in the ability to create self-sustaining populations in areas they reach through external forces, as the climate is no longer a limiting factor for their life-cycle there. This way species can reach an area expansion not just by climate change but rather as a result of the conditions it enables. This is especially true for species without an ongoing active natural range expansion, only establishing breeding populations outside of their native distribution area because of an anthropogenic impact such as global trade, which is responsible for an outstandingly large number of alien species (Hulme 2021).

The situation is not different in Hungary, a country in the middle of Central Europe strongly affected by climate change (see Toreti et al. 2022 and Timár et al. 2024 for

Copyright *Áron Székely et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

agricultural impacts) and other anthropogenic impacts such as habitat fragmentation or urbanisation. Apart from a transition in weather, a handful of papers are published every year about the presence of non-native species found here for the first time due to a climate-driven range expansion or other factors (e.g. Balogh and Tóth 2024; Schlitt et al. 2024; Tóth and Balogh 2024 etc.).

The mantid fauna of Hungary traditionally consisted of one species, *Mantis religiosa* (Linnaeus, 1758), which is considered native in the country and overall in Central Europe (Rimšaitė et al. 2022). Recently a second species, *Hierodula tenuidentata* Saussure, 1869, a non-native Asian mantid has arrived in Hungary and spread rapidly in the country and in a wide range of Europe showing a northward expansion from the Mediterranean (László et al. 2023). Shortly thereafter a paper has been published by Szinetár and Kenyeres (2020) about the possible presence of a third mantid species in Hungary, *Ameles spallanzania* Rossi, 1792.

The genus *Ameles* Burmeister, 1838 belongs to the tribe Amelini Westwood, 1889. While Amelini is widespread in the Western Palearctic, *Ameles* has a mainly Mediterranean distribution, ranging from the Canary Islands and Portugal in the West to Afghanistan in the East, and contains 23 species (Villani 2020). The genus is characterised by a relatively small body size of 20 mm to 40 mm, with the males being (mostly) holopterous and the females being brachypterous. They are considered xerothermophile and thermophile species and live mostly in Mediterranean maquis and garrigue (Agabiti et al. 2010; Battiston et al. 2010; Battiston et al. 2020a; Anselmo et al. 2023).

In 2020, a single male specimen of *A. spallanzania* was reported from Hungary by Szinetár and Kenyeres (2020). To date, it is the only study mentioning this species from this country. The specimen was found in the back of a car, most likely introduced there with nursery plants placed in the trunk, that were purchased at a gardening centre in Szombathely (Western Hungary).

A. spallanzania is native in almost all of the Mediterranean countries from Morocco to Greece (Battiston and Galliani 2011). From the past few years on, a growing number of publications (e.g. Battiston et al. 2020b) mention a rapid northward expansion of this species, traditionally associated with warming climate. Schwarz and Ehrmann (2018) categorised *A. spallanzania* as a strictly Eumediterranean species native to Europe, which is currently expanding its range. Apart from Hungary, it has recently been reported from several locations in Northern Italy (Ballini and Wilhalm 2014; Ciracì 2016; Buzzetti et al. 2018; de Fatis and Debiasi 2019; Anselmo 2022) and it has been mentioned from Germany (Schwarz and Ehrmann 2018), Switzerland (Borer et al. 2023) and Bulgaria (Vasilev et al. 2023).

Material and methods

During the course of the past few years, we collected data of *A. spallanzania* occurrences in Hungary. To gather distributional information, we used multiple sources. We collected relevant posts from large social media groups specialised in arthropod and other animal identification, such as the group "Állathatározó" (= animal identification) on Facebook, which is the most popular social media platform in Hungary. We asked for the exact locality and other collecting information, and in two cases we managed to collect the physical specimen as well.

Apart from that, we checked popular citizen science websites like izeltlabuak.hu (a Hungarian citizen science page with almost 500000 records (end of 2024) for identification and data collection of arthropods), iNaturalist.org and the GBIF database. The GBIF database contains several occurrences of arthropods worldwide including all publicly available records from izeltlabuak.hu with a reliable identification by a relevant professional (GBIF 2025). The use of citizen science sites in tracking non-native and invasive species is widely discussed in the literature and generally well-regarded (Encarnação et al. 2021). There were multiple cases in Hungary where citizen science was used successfully to gather data of new faunistic records, leading to new papers published (e.g. Turóci et al. 2020; Lazányi et al. 2024 etc.). We applied this method with great success, while obtaining specimens from observers enabled us to deposit voucher specimens in a public collection.

Identification of the individuals was based on the publications of Battiston et al. (2010) and Obertegger and Agabiti (2010). We checked the length of the pronotum and the morphology of eyes for identification. Based on these characteristics, the specimens were distinguishable from related *Ameles* species: in the case of *A. spallanzania*, the length of pronotum is twice as long as its width, therefore it is shorter than in other *Ameles* species; and the eyes are conical and have a small apical tubercle. *A. spallanzania* is much smaller than other mantids occurring in Hungary (*M. religiosa* and *H. tenuidentata*), having a body size of only approximately 20–40 mm, and its colour can also differ from these other two species (Fig. 1). It is also the most widely distributed species in the genus *Ameles*, with an area continuously expanding towards north, in the direction of Hungary.

All of the collected individuals were preserved and placed in the Collection of Smaller Insect Orders of the Hungarian Natural History Museum Public Collection Centre – Hungarian Natural History Museum, Budapest (**HNHM**).

Results and discussion

Material examined

Hungary • 1 ♀; Budapest, Szépjuhászné kertészet (gardening centre); 47.5284°N, 18.9532°E; 09. Nov. 2018; Dávid Horváth leg.

Hungary • 1 ♀; Veszprém county, Veszprém city, Cédrus kertcentrum (gardening centre); 47.080°N, 17.928°E; 03. Sept. 2024; Balázs Antal leg.

Figure 1. Specimens of *Amelles spallanzania* Rossi, 1792 observed in Hungary, **a.** Green colour variation, male nymph; **b.** Ochre colour variation, female. Photos by Lili Lajtár (**a**) (from iNaturalist.org, CC BY-NC 4.0), and Balázs Antal (**b**).

The examined individuals were identified as *A. spallanzania* by external characteristics shown in Fig. 2.

In total 34 observations were recorded from all across the county except eastern parts (Appendix 1.). We collected information about 45 individuals from 27 localities (Fig. 3). Apart from adult specimens, we recorded nymphs from five sightings, sometimes many specimens together, which suggests that at least in some cases, nymphs were not introduced from abroad but hatched locally.

Adults and nymphs were found simultaneously in a garden at Tata, NW Hungary in consecutive years after its local establishment. On the 11th of November 2024, three oothecae were found during the removal of four small roses (*Rosa* sp.) (Benjámin Attila Antal, Budapest, pers. comm. 2024). The oothecae were laid on the plant stems. Together with those, two oothecae of *M. religiosa* were found. This information indicates that *A. spallanzania* can reproduce in certain urban conditions in Hungary. An ootheca laid by a captured specimen found in Hungary is shown on Fig. 4.

Szinetár and Kenyeres (2020) concluded that the occurrence of *A. spallanzania* in Hungary most likely comes from introduction by garden plants rather than from a natural population, and advised that "presence-absence surveys in natural habitats would be important". In contrast, we found specimens from all life stages in anthropogenic habitats such as gardens apart from horticultures. From the current data, we can conclude that *A. spallanzania* has established a breeding population in Hungary and can be regularly found in outside urban conditions. This result supports the previously observed expansion in the literature, indicating that reaching the Carpathian Basin has not restricted the expansion of this species either.

A. spallanzania is an allochthonous (non-native) species in Hungary, meaning that it originates from a different ecosystem, occurring outside of its natural range (Ferretti and Lovari 2014). This term is not to be confused with invasive species, meaning a non-native species spreading rapidly and causing environmental or economic harm (Iannone et al. 2020). It is clear that this species does not meet the criteria for the above, therefore we can only refer to it as non-native species without raising serious conservation concerns.

According to Anselmo et al. (2023), climate change (especially the rise of the annual temperature, and of minimum winter temperature) and man-made corridors such as railways or roadsides are two factors that significantly help the dispersal of *A. spallanzania*. Schwarz and Ehrmann (2018) also mentions that in the case of this species, the artificial structures serving as stepping stones are not the only cause of the shown expansion but only an acceleration to it. However, it is essential to mention that females of *A. spallanzania* are brachypterous and males can only fly over a short distance (Battiston et al. 2010; Battiston and Galliani 2011), which means that global trade and transport could significantly accelerate its dispersal, especially in the form of oothecae (Pezzi and Bendazzi 2007).

Due to habitat alteration caused by climate change, an "extra area" becomes available for the expanding species to occupy, mostly northwards (Anselmo et al. 2023). *A. spallanzania* thrives in most environments with even a minimum level of vegetation (Cassar 2020), and can adapt its life cycle according to the geographical latitude, reacting to the corresponding change in temperature (Battiston et al. 2010; Battiston and Galliani 2011), concluding that it is very well capable of using and colonising this new suitable area. Our observations also suggest this statement, as we found the species in various degraded and artificial habitats such as horticultures and house gardens as well. According to Battiston and Galliani (2011), at latitudes above 43°, *A. spallanzania* overwinters as oothecae rather than as nymphs. Observations about the life cycle of this species in this region are yet to be seen.

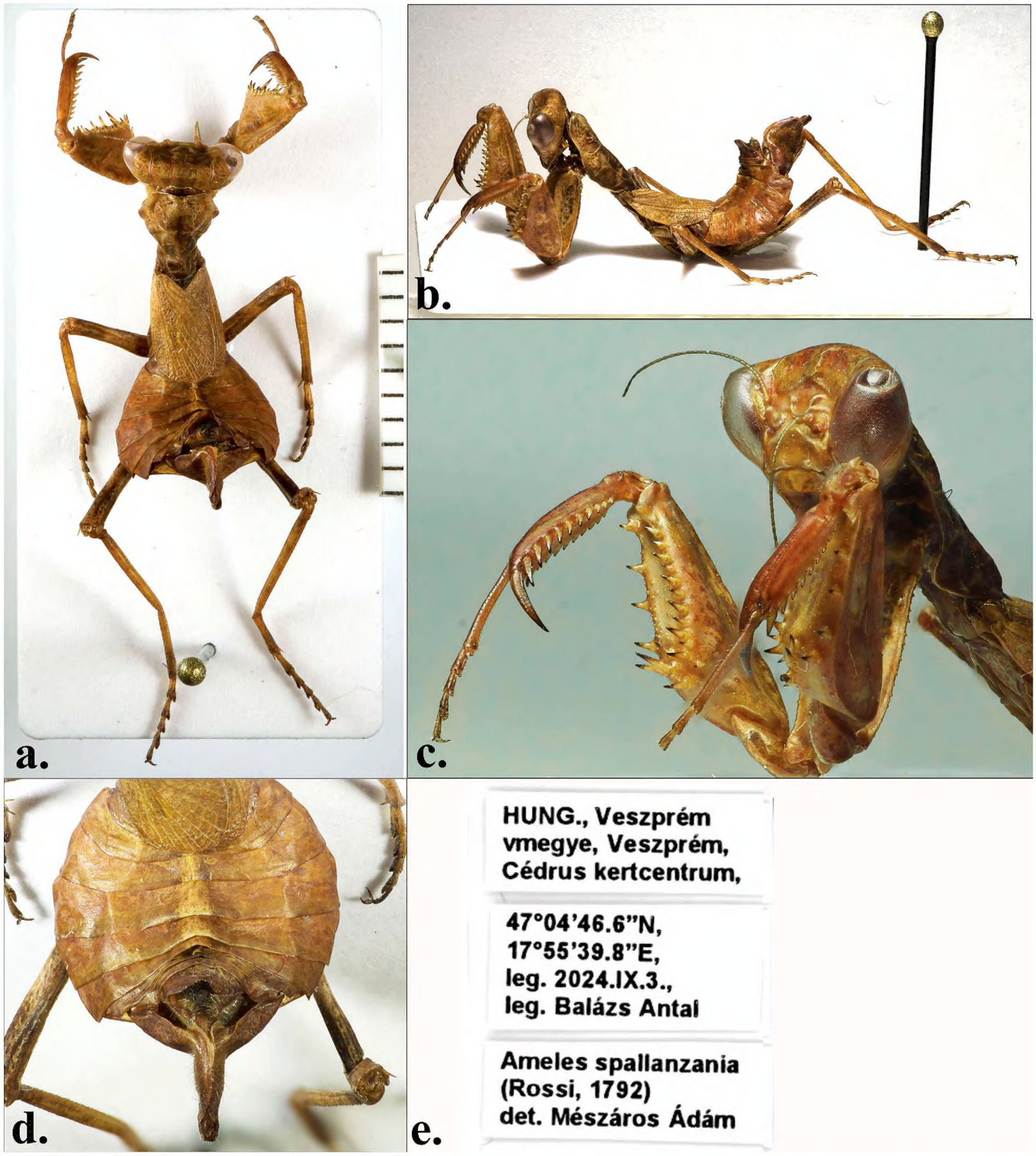

Figure 2. External characteristics of a female of *A. spallanzania* from dorsal (**a**) and lateral (**b**) view, focusing on capital, thoracic (**c**), and abdominal (**d**) traits. Specimen was collected by Balázs Antal and placed in the collection of the HNHM with its labels (**e**). Photos by Aranka Grabant.

An unexpected source of dispersal of mantid species is due to their popularity with insect breeders (Schwarz and Ehrmann 2018). This factor is seemingly marginal compared to international transport and climatic effects; however, it is present and should be taken into account.

As stated above, urban conditions seemingly provide a more suitable habitat for *A. spallanzania* in Hungary. This pattern is often observed in the early stages of biological invasions, called 'urban heat island' effect, where the milder urban microclimate creates a more favourable environment for species adapted to warmer climates (Yow 2007; Phelan et al. 2015). This effect can significantly help the species to overwinter and therefore establish populations in the area.

A. spallanzania is not the only mantid in Hungary currently expanding its range. It is worth to mention the case

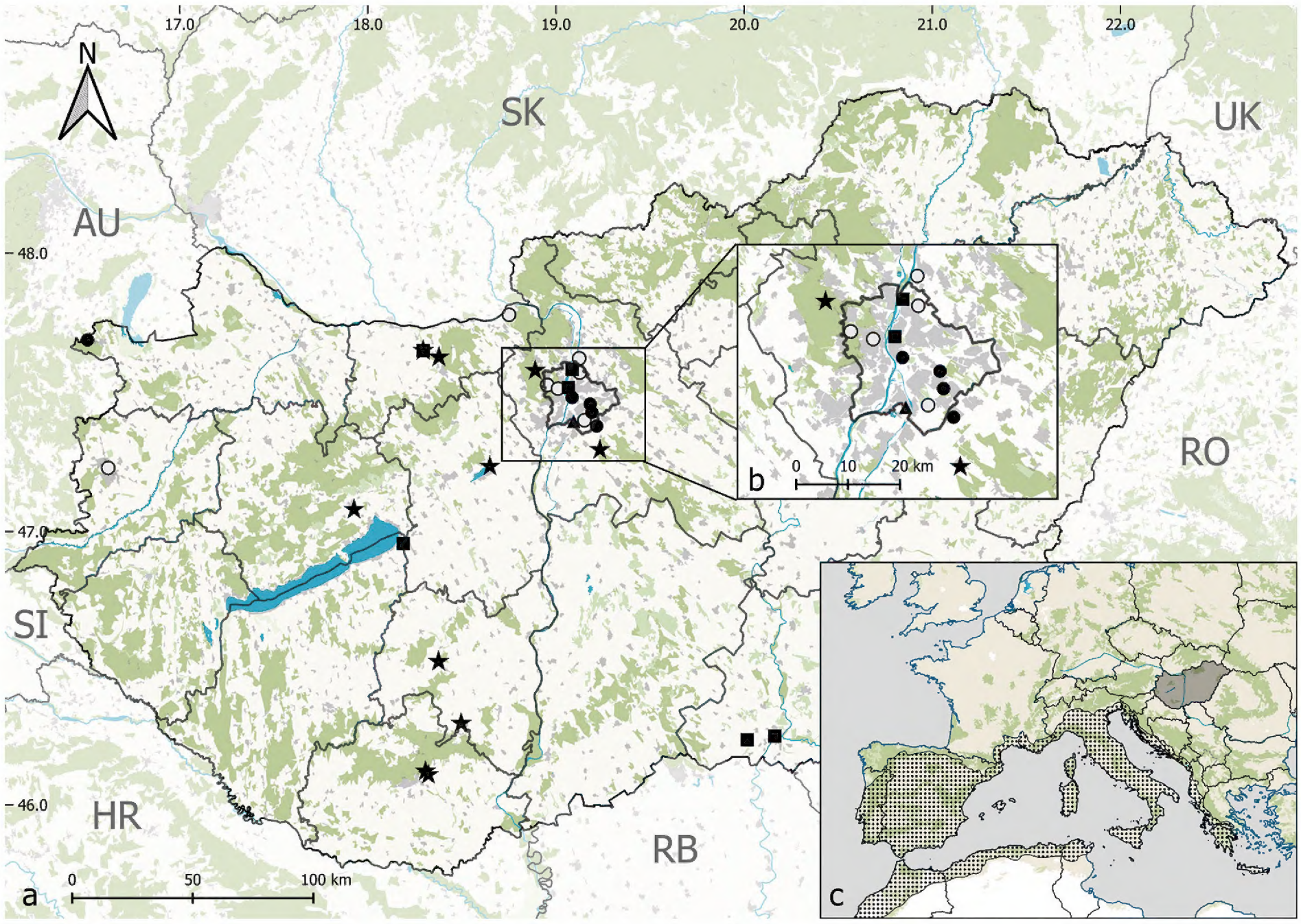

Figure 3. Observations of *A. spallanzania* in Hungary (**a**) from 2024 (star), 2023 (rectangle), 2022 (triangle), 2021 (filled circle), 2020 and before (empty circle). Observation sites in Budapest and its close surroundings are enlarged (**b**). The former European distribution of *A. spallanzania* is shown as a dotted area (based on Battiston 2020) with Hungary highlighted (**c**). Basemap: OpenStreetMap (https://openstreetmap.org/copyright).

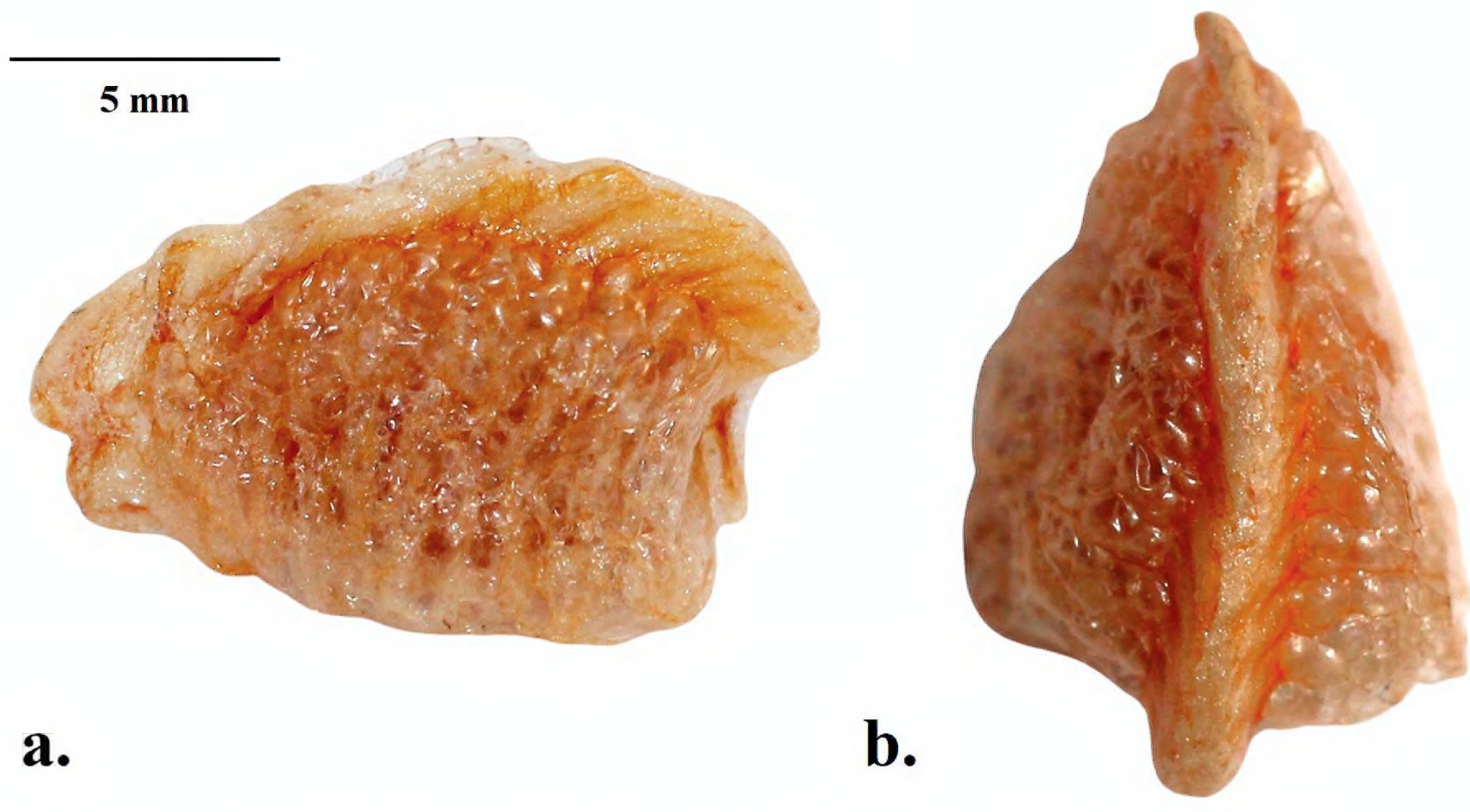

Figure 4. Ootheca of *A. spallanzania* laid in captivity. **a.** Lateral view; **b.** Dorsal view (photos by Dániel Hegyi).

of the non-native *H. tenuidentata*, which was first introduced to Europe west of Crimea in Greece (Cianferoni et al. 2018; Di Pietro and Battiston 2021) and was recorded in another Mediterranean country, Italy in 2016 (Battiston et al. 2018), from where it rapidly spread towards north. In the early stage of its introduction to Hungary, *H. tenuidentata* had a spreading pattern similar to that of *A. spallanzania*. Initially, in 2019, individual specimens were observed. Shortly thereafter, the species became locally established, and it is now widespread and common in Hungary. The first observations came mostly from gardens and similar urban habitats (László et al. 2023), which also applies to *A. spallanzania*. However, the latter is less common and has fewer observations so far, which is also contributed by its smaller size and cryptic appearance. The females of *A. spallanzania* can lay up to six oothecae in their lifetime, one per two weeks (Pezzi and Bendazzi 2007). This is approximately the same number as *H. tenuidentata*, which already colonised most parts of Hungary, where the long-lived females can lay up to five oothecae (Mirzaee et al. 2021). However, both sexes of *H. tenuidentata* are holopterous and at least the males are fully capable of spreading by wing, in contrast to the brachypterous females of *A. spallanzania*, leading to a potentially higher dispersal capacity for *H. tenuidentata*, which can be important in a biological invasion (Narimanov 2022).

Besides the two introduced species, the native *M. religiosa* is also spreading towards north, which is clearly related to climate change, in particular the "increase in average annual temperature and milder winters" (Schwarz and Ehrmann 2018; Rimšaitė et al. 2022).

The question remains whether *A. spallanzania* will become invasive out of an established allochthonous species, and what impacts it might have on native fauna. Schwarz and Ehrmann (2018) hypothesize that no saturation point has been reached in the terms of occupying empty niches by mantodeans in Europe, therefore multiple species could theoretically coexist. Establishment of *A. spallanzania* is, however, too recent to conclude anything concrete; further research is needed in following the expansion of its area and the corresponding changes in conquered ecosystems.

A. spallanzania lacked a Hungarian common name up to this study. A common name may be helpful in the practice of citizen science for species monitoring, as well as in raising public awareness. Proposed Hungarian name – "Spallanzani-törpemanó".

Acknowledgements

The authors would like to thank Aranka Grabant (HNHM) for photographing the specimens, Dániel Hegyi (Institution of Biology, ELTE) for photographing the ootheca, Sándor Noel Kádár (Budapest, Hungary) for collecting observations, Gellért Puskás (HNHM) for collecting observations and checking the relevant collection of the HNHM for additional specimens and all who contributed data for us. We thank the anonymous reviewers for their suggestions, which significantly helped to improve our manuscript.

References

Agabiti B, Salvatrice I, Lombardo F (2010) The Mediterranean species of the genus *Ameles* Burmeister,1838 (Insecta, Mantodea: Amelinae), with a biogeographic and phylogenetic evaluation. Boletín de la Sociedad Entomológica Aragonesa 47: 1–20.

Anselmo L (2022) First records of *Ameles spallanzania* in the Western Alps and habitat preferences. Bulletin of Insectology 75(1): 157–160.

Anselmo L, Di Pietro W, Maioglio O, Battiston R (2023) The effects of short-term climate change on the range of species: the case of the expanding European dwarf mantis *Ameles spallanzania* in northern Italy (Mantodea: Amelidae). Fragmenta entomologica 55(2): 161–170. https://doi.org/10.13133/2284-4880/1528

Ballini S, Wilhalm T (2014) *Ameles spallanzania* (Rossi, 1792) (Insecta, Mantidae, Amelinae): neu für die Region Trentino-Südtirol. Gredleriana 14: 271–274.

Balogh B, Tóth B (2024) First occurrence of *Hypena lividalis* (Hübner, 1796) in Hungary (Lepidoptera: Erebidae). Folia entomologica hungarica 85: 147–151. https://doi.org/10.17112/FoliaEntHung.2024.85.147

Battiston R (2020) *Ameles spallanzania*. The IUCN Red List of Threatened Species 2020: e.T44791655A44798440. https://doi.org/10.2305/IUCN.UK.2020-2.RLTS.T44791655A44798440.en [Accessed on 21 March 2025]

Battiston R, Galliani C (2011) On the life-cycle of *Ameles spallanzania* (Rossi, 1792) (Insecta, Mantodea). Atti della Società italiana di scienze naturali e del Museo civico di storia naturale di Milano 152(1): 25–35. https://doi.org/10.4081/nhs.2011.25

Battiston R, Picciau L, Fontana P, Marshall J (2010) The mantids of the Euro-Mediterranean area. Verona, Italy.

Battiston R, Leandri F, di Pietro W, Andria S (2018) The Giant Asian Mantis *Hierodula tenuidentata* Saussure,1869 spreads in Italy: a new invasive alien species for the European fauna? (Insecta Mantodea). Biodiversity Journal 9: 399–404. https://doi.org/10.31396/Biodiv.Jour.2018.9.4.399.404

Battiston R, di Pietro W, Amerini R, Sciberras A (2020a) The praying mantids (Insecta: Mantodea) as indicators for biodiversity and environmental conservation: a case study from the Maltese and Balearic archipelagos. Biodiversity 21(3): 142–149. https://doi.org/10.1080/14888386.2020.1848623

Battiston R, Giovanni B, Corradi L, Dall'Ó M, Glerean P, Morin L, Pesarini S, Tabarelli de Fatis K, Tami F (2020b) Rotta a Nord-Est: l'espansione dell'*Ameles spallanzania*. Studi Trentini di Scienze Naturali 99: 9–13.

Borer M, Delarze R, Monnerat C (2023) Premières données d'*Ameles spallanzania* (Rossi, 1792) pour la Suisse (Mantodea: Mantidae). Entomo Helvetica 16: 209–214.

Buzzetti F, Fontana P, Marangoni F, Molinaro G, Battiston R (2018) Interessanti presenze di Ortotteroidei (Insecta: Orthoptera, Dermaptera, Mantodea) nel Vicentino. Natura Vicentina 21: 51–55.

Cassar T (2020) The praying mantises of the Maltese Islands: distribution and ecology (Mantodea). Fragmenta entomologica 52(2): 341–348. https://doi.org/10.4081/fe.2020.462

Chen I, Hill J, Ohlemüller R, Roy D, Thomas C (2011) Rapid Range Shifts of Species Associated with High Levels of Climate Warming. Science 333: 1024–1026. https://doi.org/10.1126/science.1206432

Cianferoni F, Mochi O, Ceccolini F (2018) New records of *Hierodula* Burmeister, 1838 (Mantodea: Mantidae) in Europe. Revista gaditana de Entomología 9(1): 299–308.

Ciracì A (2016) Nuova segnalazione di *Ameles spallanzania* (Rossi, 1792) (Insecta, Mantodea) dalla pianura vercellese (Piemonte, Italia Nord-occidentale). Rivista piemontese di Storia naturale 37: 199–202.

Clarke B, Otto F, Stuart-Smith R, Harrington L (2022) Extreme weather impacts of climate change: an attribution perspective. Environmental Research: Climate 1: 1–25. https://doi.org/10.1088/2752-5295/ac6e7d

de Fatis T, Debiasi D (2019) Prime segnalazioni per il Trentino (Italia) di *Ameles spallanzania* (Rossi, 1792) (Dictyoptera: Mantidae). Studi Trentini di Scienze Naturali 98: 93–95.

Di Pietro W, Battiston R (2021) *Hierodula tenuidentata* Saussre, 1869: una nuova Mantide aliena per il Veneto. Studi e Ricerche – Associazione Amici del Museo – Museo Civico "G. Zannato" Montecchio Maggiore (Vicenza) 28: 57–60.

Encarnação J, Teodósio M, Morais P (2021) Citizen science and biological invasions: A review. Frontiers in Environmental Science 8: 602980. https://doi.org/10.3389/fenvs.2020.602980

Ferretti F, Lovari S (2014) Introducing Aliens: Problems Associated with Invasive Exotics. In: Putman R, Apollonio M (Eds) Behaviour and Management of European Ungulates. Whittless Publishing, Dunbeath, UK, 78–109.

GBIF (2025) GBIF.org GBIF Occurrence Download. https://doi.org/10.15468/dl.6yavr7

Hulme P (2017) Climate change and biological invasions: evidence, expectations, and response options. Biological Reviews 92(3): 1297–1313. https://doi.org/10.1111/brv.12282

Hulme P (2021) Unwelcome exchange: International trade as a direct and indirect driver of biological invasions worldwide. One Earth 4(5): 666–679. https://doi.org/10.1016/j.oneear.2021.04.015

Iannone BV, Carnevale S, Main MB, Hill JE, McConnell JB, Johnson SA, Enloe SF, Andreu M, Bell EC, Cuda JP, Baker SM (2020) Invasive species terminology: Standardizing for stakeholder education. The Journal of Extension 58(3): 27. https://doi.org/10.34068/joe.58.03.27

IPCC (2018) Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte V, Zhai P, Pörtner H-O, Roberts D, Skea J, Shukla PR, Pirani A, Moufouma-Okia W, Péan C, Pidcock R, Connors S, Matthews JBR, Chen Y, Zhou X, Gomis MI, Lonnoy E, Maycock T, Tignor M, Waterfield T (eds.)]. In Press.

IPCC (2019) Summary for Policymakers. In: Shukla PR, Skea J, Calvo Buendia E, Masson-Delmotte V, Pörtner H-O, Roberts DC, Zhai P, Slade R, Connors S, van Diemen R, Ferrat M, Haughey E, Luz S, Neogi S, Pathak M, Petzold J, Portugal Pereira J, Vyas P, Huntley E, Kissick K, Belkacemi M, Malley J (Eds) Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. In press.

László M, Katona G, Péntek A, Nagy A (2023) Spread of the invasive Giant Asian Mantis *Hierodula tenuidentata* Saussure, 1869 (Mantodea: Mantidae) in Europe with new Hungarian data. Bonn zoological Bulletin 72(1): 133–144. https://doi.org/10.20363/BZB-2023.72.1.133

Lazányi E, Kehoma Boll P, Páll-Gergely B, Simon J, Szeder KH, Turóci Á, Katona G (2024) First records of alien land planarians (Platyhelminthes: Geoplanidae) in Hungary. Zootaxa 5403(5): 592–596. https://doi.org/10.11646/zootaxa.5403.5.6

Mirzaee Z, Ebrahimi M, Sadeghi S, Battiston R, Hajian M (2021) Mantid ootheca (Insecta: Mantodea: Hierodula) or a home for many arthropods? Iranian Journal of Science and Technology, Transaction A, Science 45: 1925–1931. https://doi.org/10.1007/s40995-021-01184-3

Narimanov N, Bauer T, Bonte D, Fahse L, Entling MH (2022) Accelerated invasion through the evolution of dispersal behaviour. Global Ecology and Biogeography 31: 2423–2436. https://doi.org/10.1111/geb.13599

O'Neill D, Shaffrey L, Neumann J, Cheffings C, Norris K, Pettorelli N (2024) Investigating odonates' response to climate change in Great Britain: A tale of two strategies. Diversity and Distributions 30(4): e13816. https://doi.org/10.1111/ddi.13816

Obertegger U, Agabiti B (2010) On the usefulness of ratios for the identification of some Mediterranean species of the genus *Ameles* Burmeister, 1838 (Insecta, Mantodea). Zootaxa 3259: 34–50. https://doi.org/10.11646/zootaxa.3259.1.2

Pezzi G, Bendazzi I (2007) La mantide di Spallanzani: note sul comportamento in natura ed in allevamento. Quaderno di Studi e Notizie di Storia Naturale della Romagna 25: 109–113.

Phelan P, Kaloush K, Miner M, Golden J, Phelan B, Silva H, Taylor R (2015) Urban Heat Island: Mechanisms, Implications, and Possible Remedies. Annual Review of Environment and Resources 40: 285–307. https://doi.org/10.1146/annurev-environ-102014-021155

Rimšaitė J, Ivinskis P, Bartkevičienė G, Bernotienė R (2022) The northward spread of the European mantis, *Mantis religiosa* (Mantodea: Mantidae): Data from Lithuania. European Journal of Entomology 119(10): 318–326. https://doi.org/10.14411/eje.2022.033

Ryan, SJ, Carlson CJ, Mordecai EA, Johnson LR (2019) Global expansion and redistribution of Aedes-borne virus transmission risk with climate change. PLOS Neglected Tropical Diseases 13(3): e0007213. https://doi.org/10.1371/journal.pntd.0007213

Schlitt B, Székely Á, Orosz A (2024) First records of *Ziczacella heptapotamica* (Kusnezov, 1928) and *Asymmetrasca decedens* (Paoli, 1932) from Hungary (Hemiptera: Clypeorrhyncha: Cicadellidae). Folia Entomologica Hungarica 85: 85–92. https://doi.org/10.17112/FoliaEntHung.2024.85.85

Schwarz C, Ehrmann R (2018) Invasive Mantodea species in Europe. Articulata 33: 73–90.

Seebens H, Blackburn T, Dyer E, Genovesi P, Hulme PE, Jeschke JM, Pagad S, Pyšek P, Winter M, Arianoutsou M, Bacher S, Blasius B, Brundu G, Capinha C, Celesti-Grapow L, Dawson W, Dullinger S, Fuentes N, Jäger H, Kartesz J, Kenis M, Kreft H, Kühn I, Lenzner B, Liebhold A, Mosena A, Moser D, Nishino M, Pearman D, Pergl J, Rabitsch W, Rojas-Sandoval J, Roques A, Rorke S, Rossinelli S, Roy HE, Scalera R, Schindler S, Štajerová K, Tokarska-Guzik B, van Kleunen M, Walker K, Weigelt P, Yamanaka T, Essl F (2017) No saturation in the accumulation of alien species worldwide. Nature Communications 8: 14435. https://doi.org/10.1038/ncomms14435

Seebens H, Bacher S, Blackburn T, Capinha C, Dawson W, Dullinger S, Piero Genovesi, Hulme PE, van Kleunen M, Kühn I, Jeschke JM, Lenzner B, Liebhold AM, Pattison Z, Pergl J, Pyšek P, Winter M,

Essl F (2020) Projecting the continental accumulation of alien species through to 2050. Global Change Biology 27: 970–982. https://doi.org/10.1111/gcb.15333

Szinetár Cs, Kenyeres Z (2020) Introducing of *Ameles spallanzania* (Rossi, 1792) (Insecta, Mantodea) to Hungary raising questions of fauna-changes. Natura Somogyiensis 35: 133–138. https://doi.org/10.24394/NatSom.2020.35.133

Timár G, Jakab G, Székely B (2024) A step from vulnerability to resilience: Restoring the landscape. Land 13(2): 146. https://doi.org/10.3390/land13020146

Toreti A, Bavera D, Acosta Navarro J, Cammalleri C, De Jager A, Di Ciollo C, Hrast Essenfelder A, Maetens W, Magni D, Masante D, Mazzeschi M, Niemeyer S, Spinoni J (2022) Drought in Europe August 2022. Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/264241

Turóci Á, Fehér Z, Krízsik K, Páll-Gergely B (2020) Two new alien slugs, *Krynickillus melanocephalus* Kaleniczenko, 1851 and Tandonia kusceri (H. Wagner, 1931), are already widespread in Hungary. Acta Zoologica Academiae Scientiarum Hungaricae 66(3): 265–282. https://doi.org/10.17109/AZH.66.3.265.2020

Appendix 1

Table A1. Hungarian observations of *Ameles spallanzania* until the end of 2024. For each new record, the following information is given: locality (settlement name and geographical coordinates with four digits (if at least the name of the road is known) or two digits (if only the town is known)), observation date, information about the individuals (number, sex and life stage (O = ootheca, N = nymph, none = adult)), name of the collector or photographer. Individuals that were preserved and placed in the collection of the Hungarian Natural History Museum are marked (*). Published data of Szinetár and Kenyeres (2020) is marked (**). The records are arranged in alphabetical order of the settlements.

Locality	Observations
Ágfalva [47.69°N, 16.51°E]	5.XII.2021, 1 ♂, Miklós Németh
Alsótekeres [46.9562°N, 18.1877°E]	13.X.2023, 1 ♀, Bernadett Plecskó-Borók
Bonyhád [46.2996°N, 18.4956°E]	2.X.2024, 1 ♀, László Ajtony
Budapest [47.4015°N, 19.1507°E]	14.IX.2015, 6 ♂♀N, Tamás Soós and Zoltán Bebesi
Budapest [47.5285°N, 18.9532°E]	18.IX.2018, 1 ♀, Attila Simonyi and Dávid Horváth
Budapest [47.5285°N, 18.9532°E]	20.X.2018, 1 ♀, Dávid Horváth
Budapest [47.5285°N, 18.9532°E]	9.XI.2018, 1 ♀*, Dávid Horváth
Budapest [47.5728°N, 19.1255°E]	5.XI.2020, 1 ♀, Patrik Tóth
Budapest [47.4836°N, 19.0851°E]	3.X.2021, 1 ♀, Linda Renáta Rákosi
Budapest [47.4601°N, 19.1812°E]	18.X.2021, 1 ♀, Kurszán Gál
Budapest [47.43°N, 19.19°E]	27.X.2021, 1 ♀, Barcsi Éva Böghyné
Budapest [47.3978°N, 19.0932°E]	23.VIII.2022, 1 ♀N, Zsuzsanna Kis
Budapest [47.5839°N, 19.0856°E]	17.X.2023, 1 ♀, Rita Szilvásiné Kőhalmi
Budapest [47.5195°N, 19.0653°E]	26.X.2023, 1 ♀, Viktor Vörös
Domaszék [46.2388°N, 20.0152°E]	11.X.2023, 1 ♂, Lili Lajtár
Dunakeszi [47.6240°N, 19.1230°E]	1.IX.2016, 1 ♀, Ferenc Bognár
Esztergom [47.78°N, 18.75°E]	15.VIII.2017, 1 ♂N, Norbert Kaszás
Gyál [47.3808°N, 19.2156°E]	13.X.2021, 1 ♀, Anita Wenglazz
Nagykovácsi [47.5805°N, 18.8890°E]	29.VIII.2024, 1 ♀N, Benjámin Attila Antal
Ócsa [47.2953°N, 19.2327°E]	24.VIII.2024, 1 ♀, Viktor Kubik
Pécs [46.1106°N, 18.3215°E]	27.VIII.2024, 1 ♀N, Krisztina Heléna Szeder
Pécs [46.1234°N, 18.3061°E]	29.VIII.2024, 1 ♀, Anita Czakó
Szakály [46.5262°N, 18.3757°E]	6.IX.2024, 1 ♂, Diána Balogh
Szakály [46.5262°N, 18.3757°E]	16.IX.2024, 1 ♂, Diána Balogh
Szeged [46.2526°N, 20.1624°E]	10.IX.2023, 1 ♀, Gábor Gánóczy
Szombathely [47.23°N, 16.62°E]	10.X.2020, 1 ♂**, Csaba Szinetár
Tata [47.6521°N, 18.2941°E]	30.X.2023, 1 ♀, Benjámin Attila Antal
Tata [47.6521°N, 18.2941°E]	3.X.2024, 3 ♀, Benjámin Attila Antal
Tata [47.6521°N, 18.2941°E]	14.X.2024, 3, Benjámin Attila Antal
Tata [47.6521°N, 18.2941°E]	11.XI.2024, 3 O, Benjámin Attila Antal
Velence [47.2355°N, 18.6482°E]	25.XI.2025, 1 ♀, Bálint Takács
Vértesszőlős [47.6282°N, 18.3778°E]	19.IX.2024, 1 ♀, Benjámin Attila Antal
Vértesszőlős [47.6282°N, 18.3778°E]	25.X.2024, 1 ♀, Benjámin Attila Antal
Veszprém [47.0795°N, 17.9265°E]	3.IX.2024, 1 ♀*, Balázs Antal